ERDC/CHL CHETN-XIV-35
September 2013

US Army Corps of Engineers®

Regional Sediment Management for Atlantic Coast of Maryland and Assateague Island Seashore (Assateague By-Pass Project)

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PURPOSE. This Coastal and Hydraulics Engineering Technical Note (CHETN) describes Regional Sediment Management (RSM) activities and investigations performed by the US Army Corps of Engineers (USACE), Baltimore District (NAB), along Maryland's Atlantic Coast at Fenwick Island, the Ocean City Inlet, and the Assateague Island National Seashore. An evaluation was performed of beach renourishment and sand bypassing along the Atlantic Coast of Maryland at the Assateague Island shoreline to develop a holistic approach to understanding the overall sediment transport system. This evaluation was undertaken to investigate the fate of dredged material placed along the shore, and the short- and long-term impacts of that placement to the ebb shoal. A better understanding of these impacts will assist in predicting the ability of the ebb shoal to replenish itself, to estimate the effects dredging will have on the borrow area compared to the overall system, and ultimately to optimize NAB dredging operations with better informed decisions regarding where to dredge.

BACKGROUND. NAB is developing a holistic RSM approach to numerically model and better understand sediment transport along the local eastern seaboard of the State of Maryland (Figure 1). NAB's coastal RSM initiative includes Fenwick Island, the Ocean City Maryland Inlet, and the Assateague Island National Seashore (Figure 2).

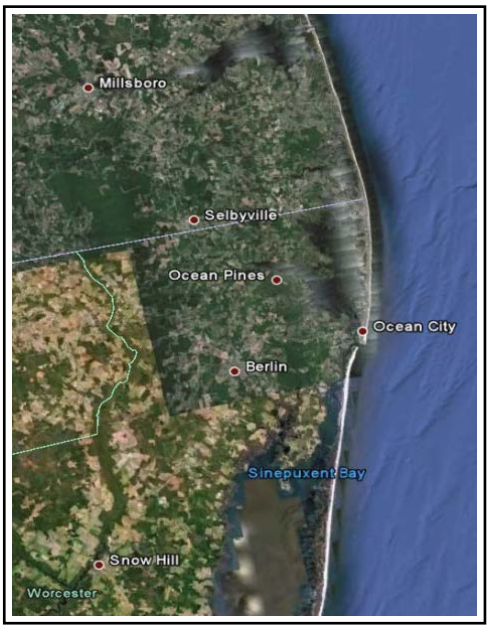

Figure 1. Maryland Atlantic seaboard RSM initiative.

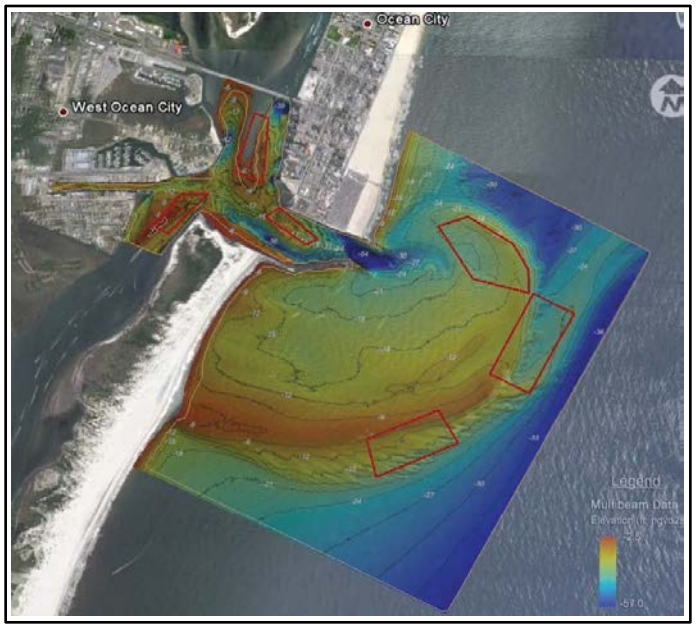

Figure 2. Dredging locations around the Ocean City, MD, inlet and ebb shoal.

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
SEP 2013		**00-00-2013 to 00-00-2013**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Regional Sediment Management for Atlantic Coast of Maryland and Assateague Island Seashore (Assateague By-Pass Project)	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **US Army Engineer Research and Development Center,Coastal and Hydraulics Laboratory (ERDC-CHL),Vicksburg,MS, 39180**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**11**	

In 1998, NAB conducted and approved the Ocean City, MD, and vicinity water resources study final integrated feasibility report and environmental impact statement (USACE 1998). The study included a sediment budget analysis which indicated that sand bypassing was needed to offset the loss of sand incurred due to the jetties (diverted offshore or into the inlet). The jetties were constructed in the 1930s after a breach of the barrier island occurred at Ocean City, MD, separating Assateague Island and Fenwick Island. This breach, in conjunction with the construction of the jetties, disrupted the natural transport of sand (predominately from north to south) throughout the littoral system. The result has been sediment starvation of Assateague Island. The National Park Service (NPS), which manages the Assateague Island National Seashore, would like to keep the park in an evolving "natural" state (including preserving overwash which provides piping plover habitat). Based on the results of the 1998 study, NAB initiated artificial sand bypassing to preserve the island (i.e., to prevent breaching and severe erosion). This activity is currently conducted on an annual basis.

Located on the back side of Fenwick and Assateague Islands are numerous Federal channels that are used for navigation and commerce. Since 2004, sand has been bypassed to Assateague Island from the inlet and bay navigation channels, and from three areas of the ebb tidal shoal. Bypassing occurs in the spring and fall of each year. The total annual volume dredged and placed is approximately 150,000 cubic yards (cu yd). The sand is placed in the surf zone of the National Seashore to replenish the littoral system that has been interrupted by the jetties. The maintenance dredging from the Federal channels and from the Ocean City Inlet and ebb shoal provides sediment that is placed on Assateague Island. Figure 2 shows the dredging locations.

LEVERAGING OPPORTUNITIES. Participating partners include the NPS Assateague Unit and the Town of Ocean City; other non-funding partners and stakeholders including the Maryland Department of Natural Resources, US Fish and Wildlife Service, National Oceanic and Atmospheric Administration, Maryland Geological Survey, and the Maryland Coastal Bays Program. All participating partners will continue to be sought out by NAB for leveraging opportunities.

The NAB Assateague Island and the Atlantic Coast projects have provided most of the bathymetric data for this RSM initiative. These two projects will continue to be important sources of future data for the continued RSM initiative in this region. Numerical simulation models developed by the US Army Engineer Research and Development Center (ERDC), Coastal Inlets Research Program's Coastal Modeling System (CMS) (Sanchez et al. 2011), will use the most current data available. Other models will use more historical bathymetry. Different features of these models will provide various insights to individual projects such as the Assateague Island and the Atlantic Coast. This is a significant leveraging opportunity.

Another leveraging opportunity occurred in 2012 through an ERDC Dredging Operations and Technical Support (DOTS) program request to train NAB personnel on implementation of the CMS-Flow (Buttolph et al. 2006a, Wu et al. 2010) and CMS-Wave (Lin et al. 2008) models.

CHALLENGE. On average, sand is placed on Assateague Island in two distinct areas twice a year, but the effects of these sand placements are not readily apparent. Information gained through beach profiles, underwater profiles through the surf zone, and NPS staff observations have led NAB to move placement sites further south. As placement sites are moved south and further from Ocean City Inlet, the effect has reduced the volume of material placed in a given timeframe, and therefore increased the cost to place the same volume of material. Hence, gathering the most accurate information on how

placed sand migrates will enable more efficient and cost effective sand bypassing. The issue is whether the placement is in the correct location to allow for a southerly drift.

Additionally, the borrow areas on the ebb shoal have not recharged as quickly as predicted. Other areas may need to be identified as sources for dredging (borrowing). There are also questions regarding how sediment is filling in the Federal channels and inlet. The optimal amount of material to remove from Federal channels to reduce the amount of maintenance dredging required within these channels is presently unknown. Measurement and modeling of the sediment movement in these areas would provide key information for understanding and managing the sediment resources in the Ocean City Inlet and the Assateague/Fenwick Island system. Figure 3 shows the overall Assateague bypassing area.

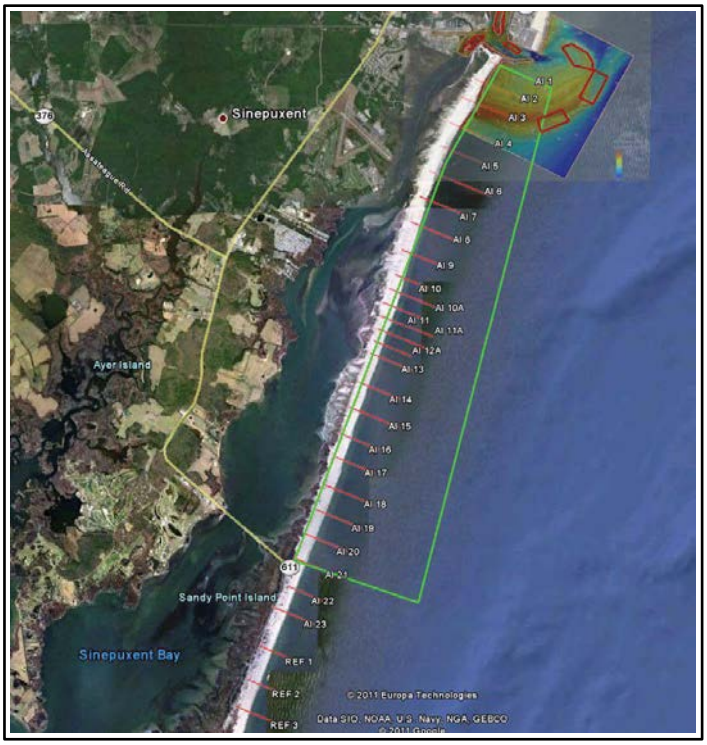

Figure 3. Ocean City Inlet, MD, and Assateague Island placement area with profile lines.

EXAMINATIONS AND ACCOMPLISHMENTS. In 2012, NAB updated and applied a numerical model previously applied to the Ocean City Inlet and the Assateague/Fenwick Island system. The model was updated with new bathymetry, grid, and parameters for the area. This resulted in a current working model and provided a foundation for future analyses of the dynamics and sediment transport in the region. This foundation model, plus future models of different phases of this system, will provide a greater understanding for managing the sediment resources in the Ocean City Inlet and the Assateague/Fenwick Island system.

NAB staff were trained on the latest version of CMS-Flow (Buttolph et al. 2006a, Wu et al. 2010) (telescoping grid) and CMS-Wave (Lin et al. 2008) (non-telescoping grid) structure for application to the Assateague/Fenwick Island system. The RSM team investigated various ways of tracking sediment in this region, including the potential use of sand tracer studies and neutrally buoyant ping pong ball tracking. The team also investigated placement of 100,000 cu yd of dredged material at a single point within the surf zone, and tracking the migration using multiple beach profile surveys. These tracking studies were proposed to better understand how to calibrate/validate the CMS models using in situ observable measurements. However, none of these tracking techniques were implemented due to timing, funding, and uncertainty regarding return on investment.

An alternative was to apply a model with different iterations of annual data which could be compared to each other and to observations of annual sediment placement. The iterations would also be compared to the potential migration of that placement by evaluating profile line and multi-beam survey interpretations. This model and study process along with other sampling and surveys will in-

crease NAB's understanding of how the coast is reacting to bypassing efforts, in the absence of other viable measurements such as tracer studies. This is an important first step in representing the impacts of dredging inside the Ocean City Inlet, the navigation channels, and on the ebb shoal.

SURVEYING AND NOURISHMENT. Since artificial bypassing began in 2004, there have been three different placement area configurations used along Assateague Island. The annual volume dredged and placed is approximately 150,000 cu yd with the sand placed in the surf zone. During the 2004 through 2008 dredging cycles, material was placed in the bounded area between profiles AI10-AI12A (Figure 4).

In 2009, the single placement area was split into two placement areas that ran roughly between profiles AI9-AI10 and AI12A-AI14. This configuration was also used in 2011. Figure 5 shows the two placement areas in close proximity to each other.

In 2010, the southern placement boundaries were moved farther south, approximately between AI17-AI19. This configuration correlates well with the recommendations of Offshore and Coastal Technologies, Inc. (OCTI 2011) which recommended moving the placement boxes to a point approximately 4.5 miles south of the jetty (below the nodal point thought to be 4.3 miles south of the jetty). It was also recommended that the 2012 placement be the same as the 2010 placement. Figure 6 shows the 2010 and 2012 placement boundaries.

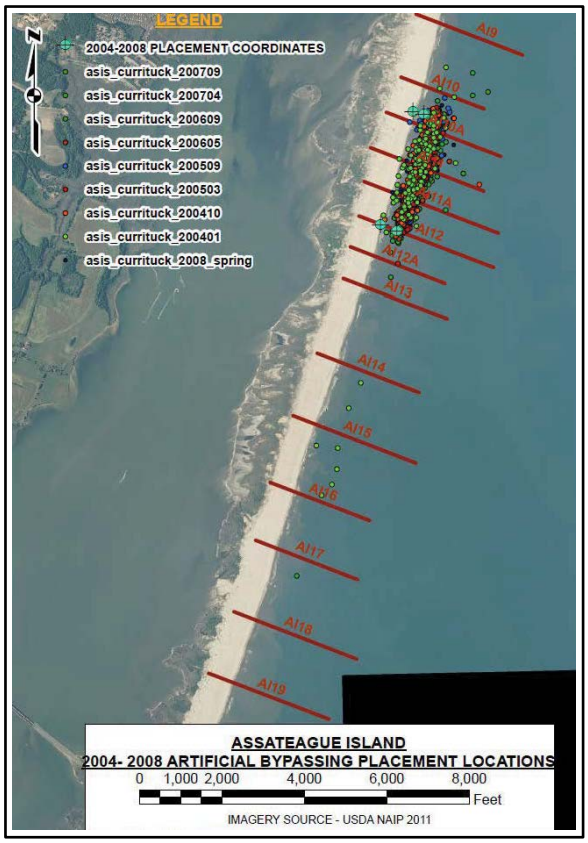

Figure 4. Placement area, 2004-2008.

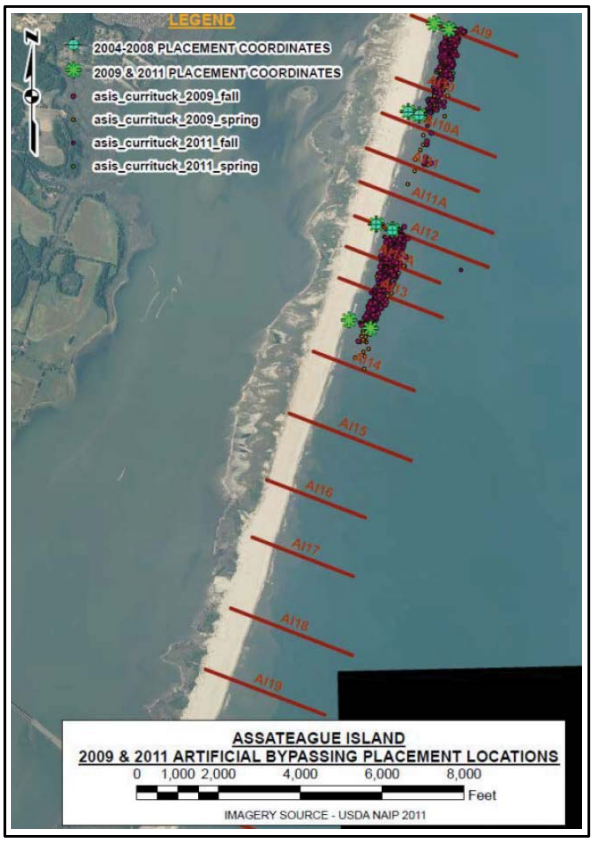

Figure 5. Placement area, 2009 and 2011.

Based on the OCTI (2011) report, the design team designated that the 2012 placement boundaries would be the same as the 2010 boundaries. This allows for the southern placement area to be located below the nodal point approximately 4.3 miles south of the jetty as indicated in the 2011 report. This adjustment should allow for a higher likelihood of sand moving further to the south, and allow the beach to perform more efficiently. Placement decisions have thus far been based on best assumptions from analysis of profile line surveys (Figure 7) as to where a nodal point was occurring.

Monitoring of the Federal channel and ebb shoal, along with the creation of a littoral transport model along the Atlantic Coastline, will enable NAB to create a model to provide design guidance for the Civil Works team planning material placement sites on the Assateague Island project.

Figure 6. Placement area, 2009 and 2011.

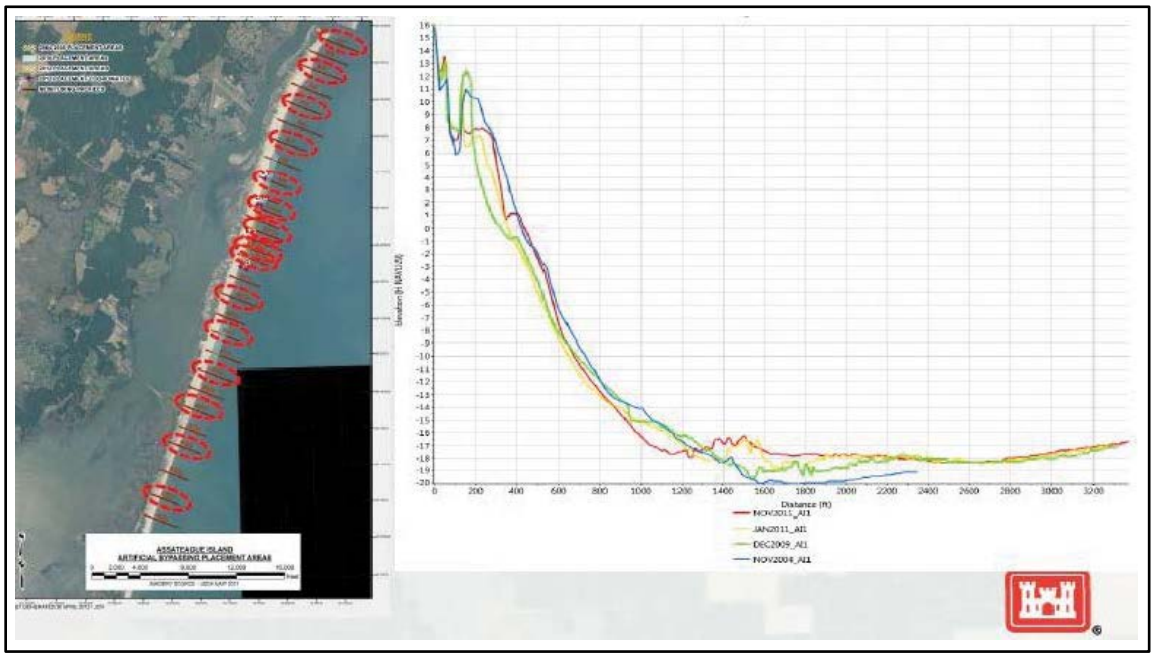

Figure 7. Profile comparison for placement decisions.

ERDC MODEL UPDATE. In August 2012, NAB applied CMS (Demirbilek and Rosati 2011) to the Ocean City Inlet and the Assateague/Fenwick Island System (Buttolph et al. 2006b). The model was updated with the latest imagery and bathymetry (Figure 8).

The updated bathymetry shows multiple old and new survey data combined for the overall coverage of this initial base line model. Bathymetry was updated with profile surveys from January 2011 for Assateague Island and December 2011 for Ocean City, and a February 2011 multi-beam survey for the Ocean City Inlet and ebb shoal. Bathymetry for the Isle of Wight and Assawoman Bays (north of the Inlet) and Sinepuxent Bay (south of the Inlet) compose the oldest data in this initial model. These areas need to be updated with new surveys. NAB is investigating collecting a multi-beam survey along Assateague Island.

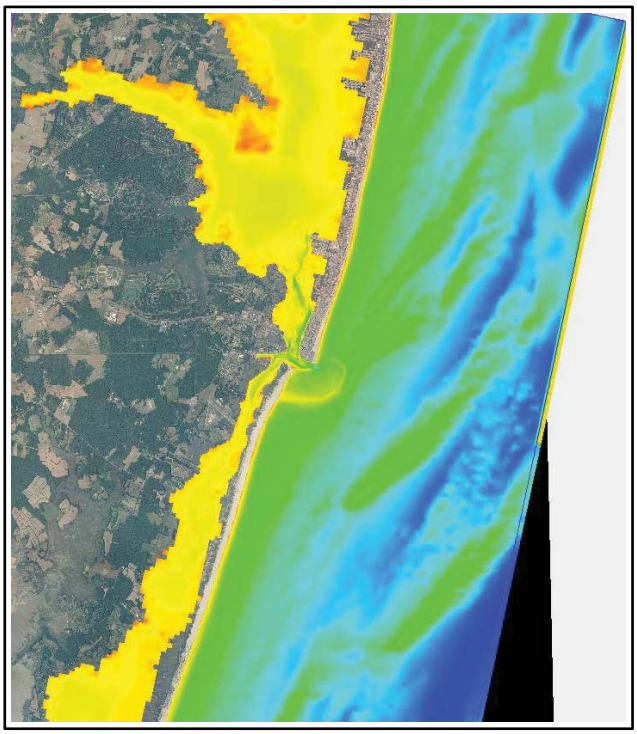

Figure 8. Updated bathymetry.

Once the new and older bathymetries were assembled, a CMS grid was developed that mimicked the original ERDC model grid that was acquired in August 2012 with a few modifications (Figure 9).

For the initial CMS model application, the same tidal signature (30 days [720 hours] of data from September 2004) from the original ERDC model was used for forcing. After the CMS model was fully configured and verified, water surface elevations, velocity vectors, and velocity magnitudes were produced (Figures 10 and 11, respectively). Figure 10 shows the velocity vectors for an incoming tide. Figure 11 shows the tidal current magnitudes for an outgoing tide.

The CMS modeling represents the first step in developing a long-term RSM system of model updates for providing a better understanding of the ever-changing nature of this coastline.

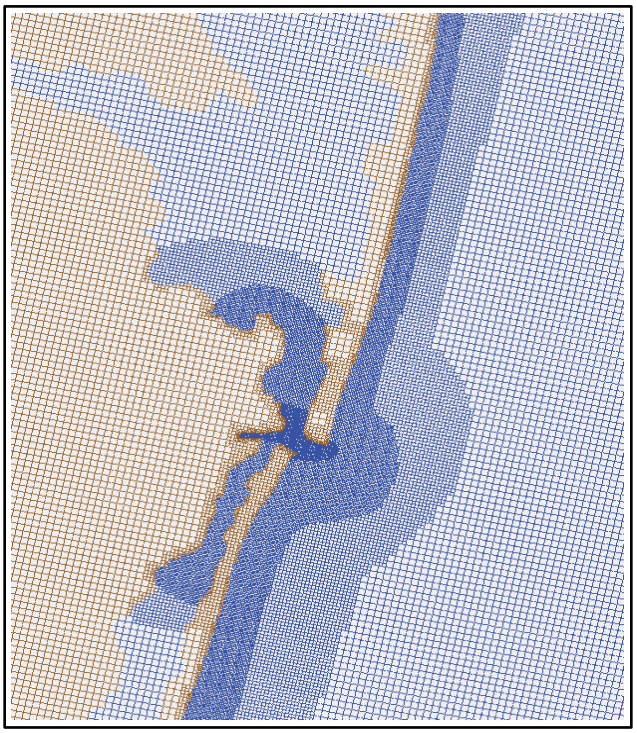

Figure 9. Updated implicit (telescoping) grid.

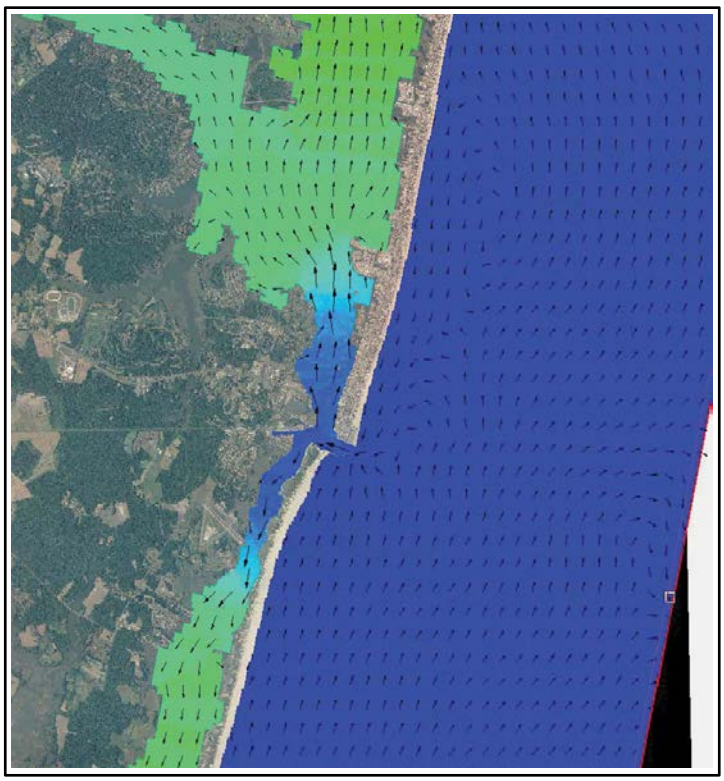

Figure 10. Model results showing velocity vectors of the tidal flux.

Figure 11. Model results showing tidal current magnitude as flow moves out of the inlet.

In the future, along with additional updated bathymetry, the wave and sediment transport portions of the CMS model should be applied. These updates and CMS model enhancements will provide NAB with a firm foundation for future analyses of coastal dynamics and sediment transport over this system.

NEAR-TERM TASKS. To continue the RSM investigations, bathymetries of the Isle of Wright, Assawoman, and Sinepuxent Bay areas need to be updated. NAB will need to obtain these data to further understand where and how material is moving.

Complete survey data for all components of sediment transport are required to accurately model sediment transport patterns and pathways, and to manage it appropriately. This includes ocean, inlet, channels, and bay bathymetry. Some placed material could be lost due to overwash of the beach and deposited on the bayside of Assateague Island. The RSM team will use data from the latest multibeam survey and any additional data (profile lines and bathymetry) procured in the fall of 2012. Once the CMS model is fully updated with the available data, it will be calibrated using historical profiles as survey comparison and sand samples for sediment grain sizes.

The updated CMS model should form a baseline for all future models concerning the Assateague Island bypassing project. The model will depict the impacts of dredging inside the Sinepuxent Bay, Assawoman Bay, Isle of Wight Bay, the Ocean City Inlet, and from the ebb shoal. With the implementation of particle tracking and sediment transport tools, this CMS model will be used to estimate the transport rates and directions before and after material has been dredged and placed in the littoral zone along the Assateague Island National Seashore.

CONCLUSIONS. The ability of NAB to implement the ERDC CMS models to assist in planning and implementing effective decision making should lead to overall lower costs for dredging and restoration of the NAB Atlantic Coast region. Shorter hauling distances to the placement site, knowledge that allows for selection of optimal borrow and placement sites as well as more precise volumes to be placed, identification of sand deficient areas, and potential solutions to reduce the amount of sand entering the inlet from the ebb shoal, are all benefits of well-implemented RSM. These benefits will all arise from field surveys, sampling, analyses, and the insight provided from the NAB RSM Ocean City Inlet and Assateague/Fenwick Island numerical simulation modeling with CMS.

ADDITIONAL INFORMATION. This Coastal and Hydraulics Engineering Technical Note (CHETN) was prepared by Thomas D. Laczo, Michele L. Gomez, and Robert N. Blama, US Army Engineer District, Baltimore, MD (NAB). Regional Sediment Management (RSM) for the Atlantic coast of Maryland and for the Assateague Island Seashore is supported by multiple entities, including the National Park Service Assateague Unit and the Town of Ocean City, MD. Other non-funding partners and stakeholders include the Maryland Department of Natural Resources, the US Fish and Wildlife Service, the National Oceanic and Atmospheric Administration, the Maryland Geological Survey, and the Maryland Coastal Bays Program. This study was supported by the USACE RSM Program. Additional information pertaining to the RSM Program can be found at: http://rsm.usace.army.mil

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This ERDC/CHL CHETN-XIV-35 should be cited as follows:

Laczo, T. D., M. L. Gomez, and R. N. Blama. 2013. *Regional Sediment Management for Atlantic coast of Maryland and Assateague Island Seashore (Assateague by-pass project)*. Coastal and Hydraulics Engineering Technical Note ERDC/CHL CHETN-XIV-35. Vicksburg, MS: US Army Engineer Research and Development Center, Coastal and Hydraulics Laboratory (ERDC-CHL), http://chl.erdc.usace.army.mil/library/publications/chetn/pdf/chetn-xiv-35.pdf

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ACRONYMS AND ABBREVIATIONS.

Term	Definition
CHETN	Coastal and Hydraulics Engineering Technical Note
CHL	Coastal and Hydraulics Laboratory
CMS	Coastal Modeling System
DOTS	Dredging Operations and Technical Support
ERDC	Engineer Research and Development Center
NAB	US Army Corps of Engineers, Baltimore District
NPS	National Park Service
OCTI	Offshore and Coastal Technologies, Inc.
POC	Point of Contact
RSM	Regional Sediment Management
US	United States
USA	United States of America
USACE	US Army Corps of Engineers